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June 21, 1960

I-Men-1-D,E
Lab Auth 2196-20-S

Mr. F. N. Hveem
Materials & Research Engr.
Materials & Research Dept.
Division of Highways
Sacramento, California

Dear Sir:

Submitted for your consideration is:

AN INVESTIGATION

of the

SUBSURFACE AND SURFACE

DRAINAGE CONDITIONS

on

ROAD I-Men-1-D,E

between

4.1 MI. NORTH OF FORSYTHE CREEK AND RIDGEWOOD SUMMIT

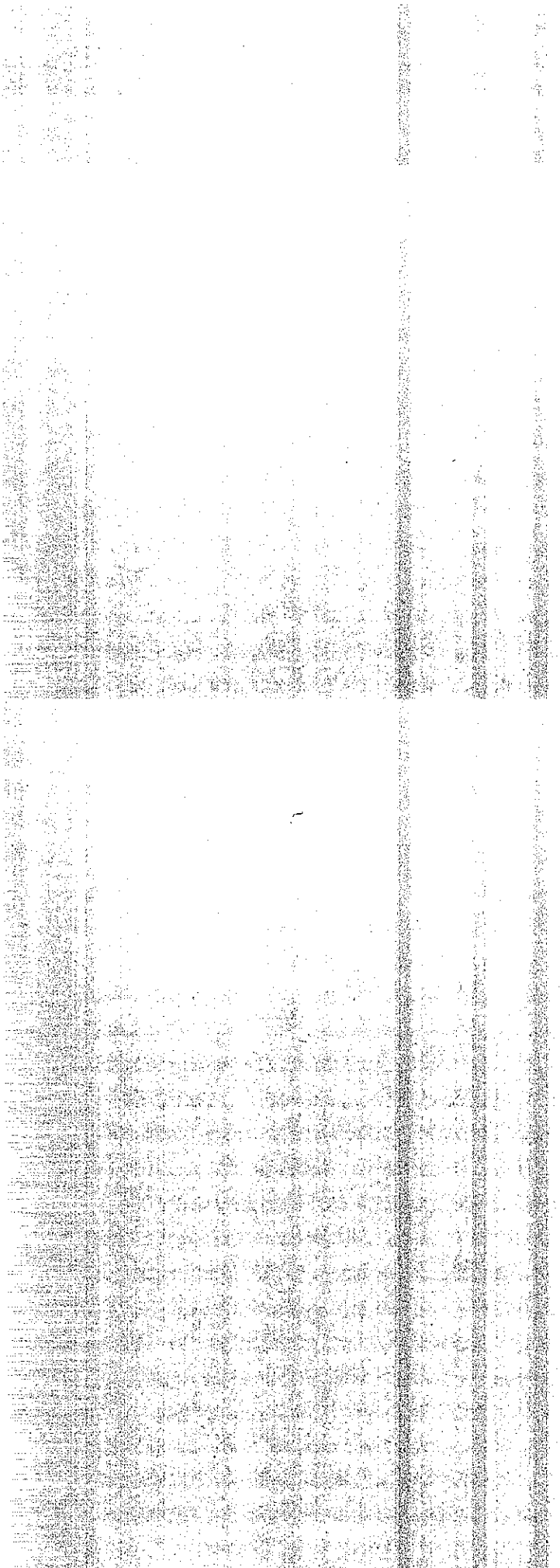
60-26

Study made by..... Foundation Section
Under general direction of..... A. W. Root
Work supervised by..... T. W. Smith
Report prepared by..... C. A. Reyner
T. W. Smith

Very truly yours,

A. W. Root
Supv. Mtls. & Research Engr.

Attach
cc:Pavement Section
Administration Section



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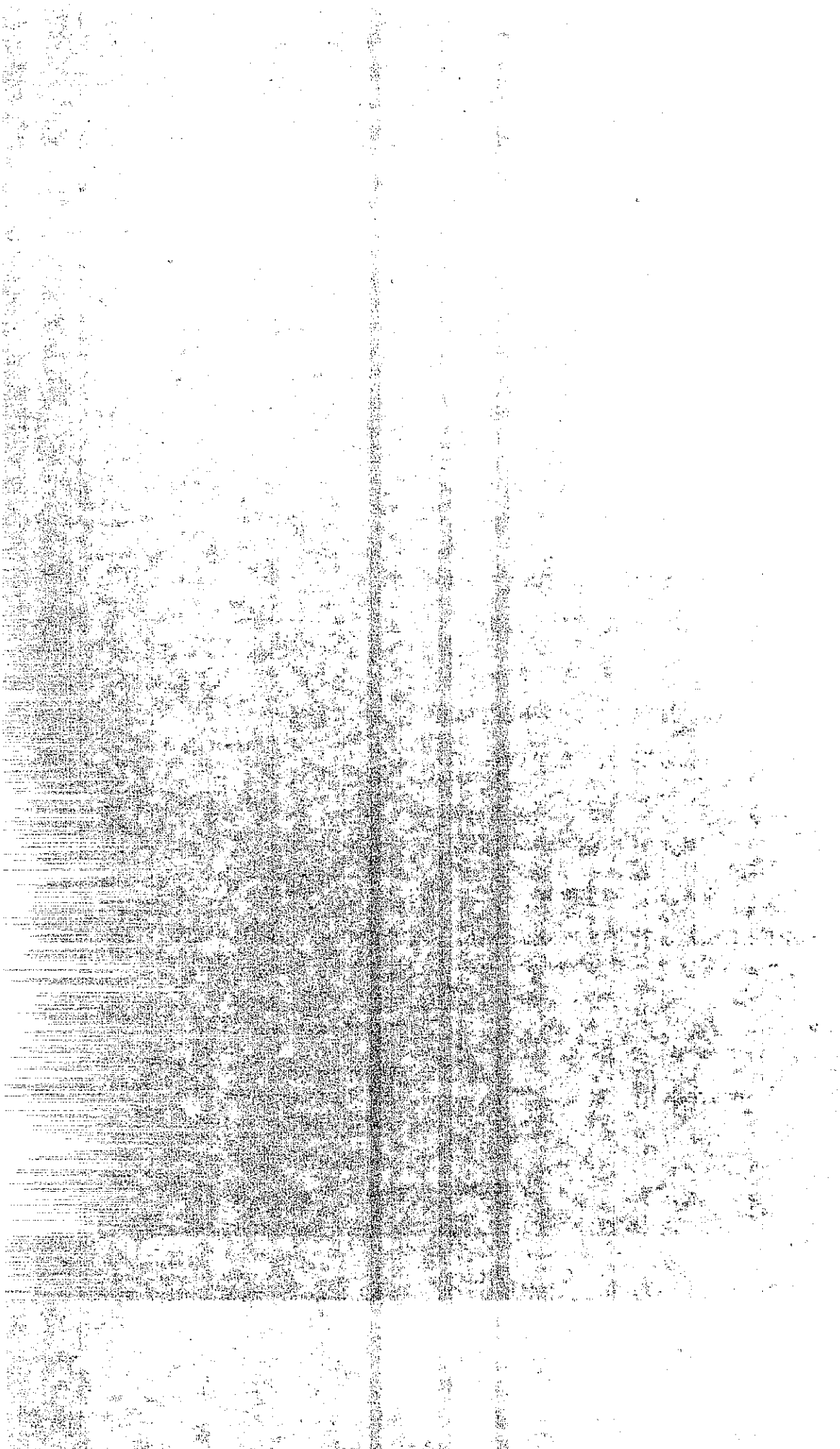


The project on road I-Men-1-D,E, between 4.1 miles north of Forsythe Creek and Ridgewood Summit, was completed in November of 1954. During the summer of 1955 an investigation was carried out by District I and Headquarters Laboratory personnel to determine the causes of premature pavement failures. The findings of the investigation and recommendations are included in a report titled, "An Investigation of the Causes of Distress Appearing in a Bituminous Surface Road in Mendocino County," dated January 13, 1956.

Listed below are some of the conclusions from the above report:

1. There is free water present under the pavement after rains and seepage through the pavement is evidence that the subdrainage system for the roadway is either inadequate or not functioning properly.

2. The C.T.B. is badly broken, permitting loads on the underlying soils greater than were anticipated in the design of the structural section.

3. Deflections throughout the job were relatively high.

A contract was let in the summer of 1957 to rehabilitate some of the underdrains and to construct 3,250 lineal feet of new underdrains. Al Franks of this department observed the work on this contract and a report titled: "Observation of Underdrain Rehabilitation," dated October 7, 1957, points out several reasons why the original underdrains had not functioned properly. It was stated in this report that the most obvious fault of the underdrains was that a clay seal was placed over them at the level of the bottom of the subbase material; therefore, any free water that worked into the structural section had no means of escape other than up through the structural section, causing seepage through the pavement.

The pictures in the report show that most of the water that was finding its way to the underdrain trenches, while they were open, was from the structural section rather than from ground water sources.

Following the completion of the underdrain rehabilitation contract a survey was made during August, 1957, noting the flow conditions of all the stabilization trenches and underdrain outlets. The 1957 survey and a subsequent survey in March, 1959, indicated similar seepage conditions. In general, the underdrains do not carry much water, indicating

that there is very little ground water at the underdrain level, that the underdrains are not positioned to intercept and remove the subsurface water, or that due to malfunctioning of the underdrains they do not remove the subsurface water.

During the early winter of 1959 B. C. Walker, District Materials Engineer, and T. W. Smith of the Materials and Research Department, while on a field trip, discussed possible corrective measures that should be considered when this portion of the road is reconstructed. At a later date representatives of the Foundation Section agreed that inasmuch as the Materials and Research Department would probably be asked for comments in the event of reconstruction, information should be obtained as to seepage and drainage conditions immediately after a heavy rainfall and two to three weeks of dry weather following the same rainfall. After consultation with representatives of the Pavement Section it was agreed that Ray Forsythe and Charles Reyner would make the surveys when conditions permitted.

Drainage and/or seepage surveys were made during February and March of 1959 to observe the runoff flow rates and pavement pumping a few days after a heavy storm and also after an eighteen-day dry period following the storm.

This survey noted the flow occurring in all pipes, such as underdrains, stabilization trenches, crossdrains and culverts, as well as any pavement and cut slope seepages.

Table 1 lists the flow at all outlets. This table has been separated into other tabulations or lists for discussion purposes.

Table 2 lists all of the culverts that carry surface runoff across the right-of-way. The total flow had, in the eleven-day period between readings, decreased to twenty-five percent of that of the first readings.

Table 3 lists all of the underdrains. Sixty-five percent of the new or rehabilitated underdrains were dry, and most of these show no signs of having ever carried any water. Of the remaining thirty-five percent, five of the new or rehabilitated underdrains had a measurable flow after the storm and each of them had a decrease in flow after eleven days. The remainder of the underdrains that were carrying water showed seepage under the pipe in the gravel bed. This seepage appears to occur only after storms, indicating either that it is a result of surface runoff, or that the subsurface water is very responsive to rainfall.

Table 4 lists the stabilization trench outlets. The flow rates at these outlets did not change during the eleven-day period, with the exception of seven or eight outlets. These flow rates are similar to those observed in August of 1957, indicating in general that these installations are carrying water that flows at a near-constant rate throughout the year.

Pavement seepages are listed in Table 5. There is considerable pavement seepage and evidence of pumping where the C.T.B. is broken. Of the forty areas listed as showing seepage in February, 1959, only seven showed seepage in March, 1959. Only one of the seven had not reduced in area. This one area appears to be a spring or seepage in a cut section on the southbound lanes at Station "E" 402±. Thus it appears that the seepage areas are very responsive to rainfall and that most of these areas dry very quickly.

Table 6 lists areas of cut slope seepages. There are a few springs or seeps that flow the year around. These seepage areas are evident by heavy vegetation. In general, most of the water on the cut slopes is that which has permeated to a level at the bottom of the root growth of the vegetation and travels to the open cut and spills out over the cut-face causing small slides and mud flows. There are some cases where the surface water percolates down to a rock layer and travels through the fractured rock or along a bedding plane and out to the cut slope.

The average annual rainfall for the Ridgewood Summit area is fifty inches. Figure No. 1 shows the rainfall for the period January 1, 1959, to March 10, 1959. Most of the rainfall occurs during heavy storms, causing periodic high runoffs. The CMP's and RCB's are of sufficient size to take the runoff. There are two locations, right of Station "D" 209+50 and right of Station "D" 368+50, where the headwall or inlet of the pipe is not properly situated for the large flow that must be handled and some of the water bypasses the headwall and spills out onto the pavement.

There are two locations, left of Station "D" 280+00 and left of Station "D" 322±, where erosion at the outlet end of the pipe is making the area unstable.

There are places where the gutters do not have sufficient cross-sectional area to carry the flow from the cut slope without water spilling onto the pavement. If a small slide or sloughing of the cut slope occurs the gutter is dammed and all of the gutter flow spills onto the pavement. This water, once on the pavement, runs down the wheel tracks until there is sufficient super elevation to cause the water to drain from the roadway. There are areas where earth slides have caused a heave in the gutter line, destroying the intended function of the gutter.

There are two locations, right of Station "D" 246+50 and right of Station "D" 322+, where poor drainage conditions outside the shoulder line allow free surface water to collect and this water could possibly be draining into the structural section.

Since the data for this report were obtained, some areas have been reconstructed under Contract 59-1BC83-F. Most of this work was repairing fill slipouts and slide damages.

Conclusions

Many factors are believed to have contributed to the deterioration of the roadway on this project. The foundation soils are relatively poor and slipouts and slides have occurred on many portions of the road. It is believed, however, that the poor foundation soils have not been the primary cause of the distress of the pavement itself. Apparently considerable quantities of water from rainfall have penetrated the pavement and structural section. Due to the relatively steep grades involved this water has tended to flow down grade through the structural section and appear as seepage or pumping rather than make its way to the edges of the roadway. This condition has been further aggravated by the layer of pervious subbase material on most of the project. The areas where pervious subbase was placed were not necessarily provided with outlets to remove the water from the pervious subbase. It is true that underdrains were provided alongside many of these areas and transverse underdrains were provided in many instances either in the initial construction or when the underdrain system was rehabilitated. However, this condition of inadequate drainage of the pervious subbase has not been completely rectified. This water in many cases makes its way along the pervious subbase and shows up in the roadway as seepage. Even though the initial cause of distress may be difficult to determine, this condition of hydrostatic head during periods of rainfall, the broken condition of the pavement and CTB, and the relatively weak structural section have all combined to cause further deterioration of the structural section.

It is believed that these drainage conditions must ultimately be corrected or the pavement condition will continue to worsen.

Several steps are believed essential to improve the poor condition of this road. Transverse underdrains should be provided at the lower end of all of the areas where pervious subbase was placed. Additional transverse underdrains should be provided at intervals not exceeding 300 feet along all of the pervious subbase areas. There should be at least one longitudinal underdrain in each of the pervious subbase areas. This drain should be so positioned that it will provide drainage on the low side of the pervious subbase.

The removal of the subsurface water will provide only a portion of the solution. Every effort should be made to prevent water from percolating through the pavement. It would appear that the major portion of the water is entering through the roadway surface. In order to prevent this, every effort should be made to construct an impervious surface. Any deficiencies in the surface drainage facilities should be corrected.

The structural section should be reinforced as considered necessary taking into account the broken condition of the surfacing and CTB. Furthermore, observations made during the rehabilitation of the underdrains in 1957 indicated that the thicknesses of the various parts of the structural section were somewhat deficient.

It is believed that if these procedures are followed the proposed improvements should correct most of the present deficiencies which are causing the pavement distress.

The measures discussed are relatively independent of the conditions that have caused the slides, slipouts, and embankment settlements. These slides or slipouts should be investigated and treated independently as conditions indicate the need for such preventative measures or treatment.

TABLE I

Drainage Survey - All pipes

	Outlet Station	Position	Description	Flow Feb. 25 & 26, 1959	Flow Mar. 9 & 10, 1959
"D"	186+50	Left	36" CMP	10,000 gpd*	Dry
	189+90	"	8" PMP Trans. Underdrain	No flow-ground wet underpipe	Slightly Drier
	194+73	"	3' x 3' R.C.B.	432,000 gpd	34,000 gpd
	195+45	Right	UD	Could not locate outlet	--
	196+80±	Left	8" PMP & Stab. trench	Flow in bed under pipe none in pipe	No change
	200+60	"	4' x 3' R.C.B.	432,000 gpd	115,000 gpd
	200+60	Right	8" PMP Underdrain	Trickle	Pipe damp, no flow
	204+15	Left	24" CMP	2,880 gpd	771 gpd
	204+15	"	8" PMP Stab. Trench	21,500 gpd	5,400 gpd
	205+20	"	U.D.	Very wet under pipe	Dry
	205+95	"	Trans. underdrain	Dry	"
	209+30	"	24" CMP	2,880 gpd	1,136 gpd
	211+00±	"	8" PMP Stab. Trench	Dry	Dry
	212+18±	"	24" CMP	288,000 gpd	14,653 gpd
	212+90±	Right	8" PMP U.D.	960 gpd	515 gpd
	214+00	Left	8" PMP Stab. Trench	Pipe wet, very wet under pipe	Dry
	215+60	"	8" PMP Stab. Trench	Dry	"
	217+96	"	24" CMP	144,000 gpd	"
	220+50	"	8" PMP Stab. Trench	Dry	"
	221+50	"	8" PMP Trans. U.D. into D.I. of 18" CMP	Drip	"
	225+78	"	48" R.C.P.	432,000 gpd	43,200 gpd
	226+70	"	8" PMP Stab. Trench	Pipe wet, marshy & wet around pipe	Same
	229+40	"	8" PMP " "	Ditto	"
	230+23	"	24" CMP	115,200 gpd	2,160 gpd
	231+30	"	8" PMP Trans. U.D.	Dry	Dry
	237+03	"	36" CMP	216,000 gpd	14,400 gpd
	238+00	"	8" PMP Stab. Trench	Dry	Dry
	238+80	"	8" PMP Trans. UD	"	"
	241+50		24" CMP	Drip	"
	246+40	"	8" PMP UD	Dry	"
	246+50	"	36" CMP	144,000 gpd	86,200 gpd

*gpd = gallons per day

TABLE I (Cont.)

Outlet Station	Outlet Position	Description	Flow Feb. 25 & 26, 1959	Flow Mar. 9 & 10, 1959
247+10	Left	8" PMP Stab. Trench	Dry	Dry
248+50	"	8" " " " "	"	"
248+54	"	24" CMP	2,880 gpd	"
250+66	"	24" CMP	1,440 gpd	Trickle
250+00	Right	8" PMP UD	Dry	Dry
250+70	"	8" " "	"	"
256+50	Left	8" PMP Stab. Trench	"	"
257+72	"	24" CMP	144,000 gpd	21,590 gpd
257+85	"	8" PMP Stab. Trench	In slide area	--
258+90	"	8" " " "	" " "	--
260+15	"	8" " " "	" " "	--
260+50	"	24" CMP	" " "	--
260+50	"	8" PMP Stab. Trench	" " "	--
260+50	Right	8" PMP UD	" " "	--
261+50	Left	8" PMP Stab. Trench	" " "	--
263+70	"	8" PMP UD	Marshy & wet under pipe	Same
266+62	"	24" CMP	4,320 gpd	Trickle
267+00	"	8" PMP Stab. Trench	Dry	Dry
267+24	Right	8" PMP UD	Seepage underpipe	Same
269+50	Left	8" PMP Stab. Trench	2,880 gpd	Trickle
271+25	Right	8" PMP UD	Dry	Dry
271+39	Left	24" CMP	14,400 gpd	5,080 gpd
272+80	"	24" CMP	2,880 gpd	120 "
275+95	"	8" PMP Tran. UD	Dry	Dry
276+45	"	24" CMP	720 gpd	Drip
278+30	"	8" PMP Stab. Trench	Seepage under pipe	Same
279+00	"	8" " " "	Wet & Marshy at outlet	"
280+00	"	18" CMP	260 gpd	90 gpd
		Collect 8" PMP UD on right	Assume this flow from UD	
284+64	"	24" CMP	7,200 gpd	120 "
284+25	"	8" PMP Stab. Trench	14,400 "	180 "
286+35	Right	8" PMP Trans. UD	Pipe dry, seepage around pipe	Dry
288+90	Left	24" CMP	4,320 gpd	125 gpd
295+60	"	8" PMP Tran. UD	Pipe wet, seepage under pipe	Same
296+69	"	24" CMP	2,880 gpd	60 gpd
299+00	"	8" PMP Stab. Trench	Could not locate outlet	--

TABLE I (Cont.)

Outlet Sta.	Outlet Position	Description	Flow Feb. 25 & 26, 1959	Flow Mar. 9 & 10, 1959
300+44	Left	36" CMP	43,200 gpd	10,790 gpd
300+50	"	8" PMP Stab. Trench	Dry	Dry
301+50	Right	8" PMP UD not shown on plans	Drip	"
302+20	"	8" PMP Tran. UD	Seep under pipe	Same
304+96	Left	18" CMP; Catches UD on Rt.	Dry	Dry
305+60	"	8" PMP Stab. Trench	"	"
306+75	"	8" PMP " "	Pipe dry, damp under drain	Same
308+69	"	24" CMP	7,200 gpd	1,440 gpd
308+69	"	8" PMP Stab. Trench	360 "	Dry
308+69	"	8" PMP Tran. UD	Seepage under pipe, pipe dry	Same
310+57	"	18" CMP	Dry	Dry
310+70	"	8" PMP Stab. Trench	360 gpd	"
312+75	"	5' x 5' RCB	1,440,000 gpd	216,000 gpd
312+75	"	8" PMP Trans. UD	Could not locate outlet	
313+80	"	8" PMP Stab. Trench	Drip from pipe, marshy around pipe outlet	Same
314+65	"	8" PMP Trans. UD	Dry	Dry
318+21	"	24" CMP	14,400 gpd	Trickle
319+65	"	5' x 5' RCB	1,080,000 "	432,000 gpd
319+65	"	8" PMP Stab. Trench	Could not locate outlet	Same
322+00	"	8" PMP " "	8,800 gpd	Pipe damp, seepage under pipe
322+87	"	24" CMP	Dry	Dry
322+87	"	8" PMP Stab. Trench	7,200 gpd	3,600 gpd
323+50	"	8" PMP " "	Dry	Dry
324+00	"	8" PMP Tran. UD	"	"
325+00	"	8" PMP Stab. Trench	Seepage from under pipe	Same
325+72	"	18" CMP	Dry	Dry
327+00	"	8" PMP Stab. Trench	Seepage under pipe	"
328+15	"	8" PMP " "	Dry	"
329+71	"	24" CMP	216,000 gpd	172,400 gpd
330+00	"	8" PMP Sta. Trench	Seepage under pipe	Same
331+20	Right	8" PMP UD	" " "	"
332+26	Left	8" PMP UD	Dry	Dry
332+46	Right to Left	8" PMP UD	Gutter flow - 1440 gpd	360 gpd

TABLE I (Cont.)

	Outlet Sta.	Position	Description	Flow Feb. 25 & 26, 1959	Flow Mar. 9 & 10, 1959
	336+41	Left	18" CMP	360 gpd	135 gpd
	337+00	"	8" PMP Stab. Trench	Seepage under pipe	Same
	337+50	"	8" PMP " "	360 gpd	Wet under pipe
	338+50	"	8" PMP " "	Seepage under pipe	Same
	339+46	"	24" CMP	86,200 gpd	25,400 gpd
	Stationing questionable should be about 340+20				
	340+25	Right	8" PMP Tran. UD	Dry	Dry
	342+00	Left	24" CMP	360 gpd	Drip
	344+00	"	8" PMP Tran. UD	Dry	Dry
	344+25	"	8" PMP UD	"	"
	344+44	"	24" CMP	21,590 gpd	6,170 gpd
	344+50	Right	8" PMP UD	Seepage under pipe	Same
	347+81	Left	24" CMP	2,880 gpd	2,880 gpd
	349+50	"	24" CMP	21,600 "	4,550 "
	352+27	"	24" CMP	115,200 "	60,000 "
	352+32	Right	8" PMP UD	Dry	Dry
	353+85	Left	24" CMP	End of Pipe covered by slipout, marshy & very wet	--
	354+85	"	8" PMP Tran. UD	Drip	Drip
	357+78	"	18" CMP (collects UD on right)	1,440 gpd	240 gpd
	358+94	"	24" CMP	115,200 "	86,200 "
	358+50	"	8" PMP UD	1,440 "	1,440 "
	361+98	"	18" CMP	28,800 "	21,590 "
	365+50	"	24" CMP	Drip	Drip
	366+00	"	8" PMP Stab. Trench	36,000 gpd	36,000 gpd
	367+00	"	8" PMP UD Ctr.	Dry	Dry
	368+56	"	24" CMP	36,000 gpd	36,000 gpd
	369+45	"	8" PMP Stab. Trench	2,160 "	2,160 "
	370+50	"	24" CMP	7,299 "	Dry
"E"	363+00	"	24" CMP	2,160 "	432 gpd
	363+50	"	8" PMP Stab. Trench	Dry	Dry
	364+60	"	8" PMP UD Ctr.	"	"
	366+50	"	24" CMP	1,080 gpd	393 gpd
	368+00	"	8" PMP Stab. Trench	5,400 "	5,400 "
	369+22	"	24" CMP	43,200 "	28,890 "
	369+50	"	8" PMP Trans. UD	Dry	Dry

TABLE I (Cont.)

Outlet		Description	Flow Feb. 25 & 26, 1959	Flow Mar. 9 & 10, 1959
Sta.	Position			
"E" 369+65	Right	8" PMP UD	Dry	Dry
369+73	Left	8" PMP UD Ctr.	"	"
371+45	"	8" PMP Stab. Trench	Pipe dry - very wet around pipe	Same
372+61	"	24" CMP	7,200 gpd	432 gpd
373+16	Right	8" PMP UD	Dry	Dry
374+00	Left	8" PMP Stab. Trench	2,880 gpd	Drip
375+28	"	24" CMP	Dry	Dry
375+47	Right	8" PMP UD	"	"
375+95	Left	8" PMP Stab. Trench	"	"
377+90	"	8" PMP " "	"	"
378+82	"	8" PMP UD	"	"
379+40	"	18" CMP	5,260 gpd	1,440 gpd
383+30	"	8" PMP Stab. Trench	Covered by slope rehabilitation	--
384+41	"	24" CMP	240 gpd	Dry
384+50	"	8" PMP Trans. UD	Dry	"
387+75	"	24" CMP	14,400 gpd	12,340 gpd
388+50	"	8" PMP Stab. Trench (catches UD on right)	2,880 "	2,700 "
392+00	"	8" PMP UD	8,640 "	8,640 "
392+35	"	24" CMP	7,200 "	5,260 "
394+05	"	8" PMP Trans. UD	Dry	Dry
394+30	"	8" PMP UD (drain Rt. side)	1,728 gpd	1,005 gpd
394+50	"	8" PMP UD Ctr. & Lt.	Dry	Dry
398+88	"	24" CMP	7,200 gpd	6,170 gpd
399+50	"	8" PMP UD	Drip-seepage under pipe	Same
401+20	Right	8" PMP Trans. UD	Dry	Dry
405+00	Left	18" CMP	1,440 gpd	"
409+07	"	18" CMP (catches UD on right)	864 "	No flow, seepage under pipe
410+85	"	8" PMP Stab. Trench	Dry	Dry
412+51	"	24" CMP	7,860 gpd	1,920 gpd
417+00 to 420+30 Rt.		8" PMP UD	Flow (?)	Dry

TABLE 2

CMP's & RCB's

	Station		Description	Flow in Gallons per Day February 1959	Flow in Gallons per Day March 1959
Section "D"	186+50	Left	36" CMP	10,000	Dry
	194+73	"	3' x 3' RCB	432,000	34,000
	200+60	"	4' x 3' RCB	432,000	115,000
	204+15	"	24" CMP	2,880	771
	209+30	"	24" CMP	2,880	1,136
	212+18	"	24" CMP	288,000	14,653
	217+96	"	24" CMP	144,000	Dry
	225+78	"	48" RCP	432,000	43,200
	230+23	"	24" CMP	115,200	2,160
	237+03	"	36" CMP	216,000	14,400
	241+50	"	24" CMP	Drip	Dry
	246+50	"	36" CMP	144,000	86,200
	248+54	"	24" CMP	2,880	Dry
	250+66	"	24" CMP	1,440	Trickle
	257+72	"	24" CMP	144,000	21,590
	260+50	"	24" CMP	In slide area	
	266+62	"	24" CMP	4,320	Trickle
	271+39	"	24" CMP	14,400	5,080
	272+80	"	24" CMP	2,880	120
	276+45	"	24" CMP	720	Drip
	280+00	"	18" CMP	360	90
	284+64	"	24" CMP	7,200	120
	288+91	"	24" CMP	4,320	125
	296+69	"	24" CMP	2,880	60
	300+44	"	36" CMP	43,200	10,790
	304+96	"	18" CMP	Dry	Dry
	308+69	"	24" CMP	7,200	1,440
	310+57	"	18" CMP	Dry	Dry
	312+75	"	5' x 5' RCB	1,440,000	216,000
	318+21	"	24" CMP	14,400	Trickle
	319+65	"	5' x 5' RCB	1,080,000	432,000
	322+87	"	24" CMP	Dry	Dry
	325+72	"	18" CMP	Dry	Dry
	329+71	"	24" CMP	216,000	172,400
	336+41	"	18" CMP	360	135
	339+46	"	24" CMP	86,200	25,400
	342+00	"	24" CMP	360	Drip
	344+44	"	24" CMP	21,590	6,170
	347+81	"	24" CMP	2,880	2,880
	349+50	"	24" CMP	21,600	4,550
	352+27	"	24" CMP	115,200	60,000
	353+85	"	24" CMP	End of pipe covered by slipout very wet	
	357+76	"	18" CMP	1,440	240
	358+94	"	24" CMP	115,200	86,200
	361+98	"	18" CMP	28,800	21,590
	365+50	"	24" CMP	Drip	Drip
	368+56	"	24" CMP	36,000	36,000
	370+50	"	24" CMP	7,200	Dry

TABLE 2 (Cont.)

	Station	Description	Flow in Gallons per Day February 1959	Flow in Gallons per Day March 1959
Section "E"	363+00 Left	24" CMP	2,160	432
	366+50 "	24" CMP	1,080	393
	369+22 "	24" CMP	43,200	28,890
	372+61 "	24" CMP	7,200	432
	375+28 "	24" CMP	Dry	Dry
	379+40 "	18" CMP	5,260	1,440
	384+41 "	24" CMP	240	Dry
	387+75 "	24" CMP	14,400	12,340
	392+35 "	24" CMP	7,200	5,260
	398+88 "	24" CMP	7,200	6,170
	405+00 "	18" CMP	1,440	Dry
	409+05 "	18" CMP	864	"
	412+51 "	24" CMP	7,860	1,920
			5,740,000	1,471,777

TABLE 3

All Underdrains

Section "D"

Station	Description*	Aug. 1957	Feb. 1959	Mar. 1959
188+50	Old U.D.	Pipe 3/4 plugged. Outlet ditch plugged. Water backed up in pipe by dirt plug.	7,200 gpd	Dry
189+90	Old Trans.U.D.	Pipe 1/4 plugged - Dry	No flow in pipe. Wet under pipe	Same -drier
195+45	Old U.D.	Pipe 1/3 plugged. Moisture in pipe under plug	Could not locate outlet	
200+60 to 203+02 Rt.	Rehab. U.D.	Dry	Trickle	Pipe damp - no flow
205+95 Lt.	Old Tran. UD	Not listed	Dry	Dry
212+90 Rt.	U.D. Old	Dry	960 gpd	515 gpd
221+50 Lt.	Old Trans.U.D.	Dry	Drip	Dry
231+30 Lt.	Old Trans. U.D.	Dry	Dry	Dry
238+80 Lt.	Old Trans. U.D.	Not listed	Dry	Dry
250+00 to 250+58 Lt.	Rehab. U.D.	Dry	Dry	Dry
250+70 to 255+35 Rt.	Rehab. U.D.	Dry	Dry	Dry
260+50 to 263+39 Rt.	Rehab. U.D.	Moist. no flow of water	Lost in slipout	
263+70 Lt. Toe of slope	Old U.D.	Pipe dry. Gravel below wet	Marshy-free water	Same
267+24 to 271+28 Rt.	Rehab. U.D.	Dry	Seepage under pipe	Same

TABLE 3 (cont.)

Section "D"

Station	Description*	Aug. 1957	Feb. 1959	Mar. 1959
275+95 Lt.	Old Trans. U.D.	Dry	Dry	Dry
279+00 to 281+00 Rt.	Rehab. U.D.	Not listed	360 gpd	90 gpd
286+35	Old Trans. U.D.	Dry	pipe dry-seep under pipe	Dry
288+90 to 291+00 Rt.	Rehab. U.D.	Water flowing from C.M.P. Left into which P.M.P. leads	4320 gpd	125 gpd
295+60 Lt.	Old Trans. U.D.	Very slight flow of water	pipe wet - seepage under pipe	Same
302+20 Rt.	Old Trans. U.D.	Outlet crushed & plugged; gravel under P.M.P. damp.	Seep under pipe	Same
304+96 to 308+42 Rt.	Rehab. U.D.	Dry	Dry	Dry
314+65 Lt.	Old Trans. U.D.	Dry	Dry	Dry
324+00 Lt.	Old Trans. U.D.	Dry	Dry	Dry
331+20 to 332+35 Rt.	Rehab. U.D.	Damp	Seepage under pipe	Same
332+46 to 344+88 Rt.	Rehab. U.D.	Very slight flow of water	1440 gpd	360 gpd
333+00 to 337+00 Lt 332+60 to 335+40 Lt.) 332+26 to 330+00 Obl)	Common outlet - new	Dry	Dry	Dry
340+25 Rt.	Old Trans. U.D.	Pipe 1/2 plugged - Dry	Dry	Dry
344+00 Lt.	Old Trans. U.D.	Dry	Dry	Dry

TABLE 3 (cont.)

	Station	Description*	Aug. 1957	Feb. 1959	Mar. 1959
Section "D"	344+25 to 347+25 Lt.	New common outlet	Dry	Dry	Dry
	344+25 to 347+15 Lt.				
	344+50 to 347+50 Rt.	Rehab. UD	Pipe damp. Slight flow in gravel below P.M.P.	Seepage under pipe	Same
	352+32 to 353+60 Rt.	Rehab. UD	Slight flow of water	Dry	Dry
	353+85 to 357+64 Rt.	Rehab. UD	Medium flow of water	Pipe end covered due to slipout - very wet & marshy	
	354+85 Lt.	Old Trans. UD	Slight flow of water	Drip	Drip
	357+78 to 364+30 Rt. (Includes other runoff)	Rehab. UD	Dry	1440 gpd	240 gpd
	367+00 to 369+10 Lt.	Trans. UD (New)	Dry	Dry	Dry
Section "E"	364+60 to 366+15 Lt.	New	Dry	Dry	Dry (Slipout at end of pipe)
	369+65 Rt.	Old Trans.UD	Not listed	Dry	Dry
	369+73 Rt.	Old U.D.	Dry	1080	Drip
	369+73 to 370+67 Lt.	New	Dry	Dry	Dry
	373+16 to 374+25 Rt.	Rehab. UD	Dry	Dry	Dry
	375+16 to 377+57	Rehab. UD	Dry	Dry	Dry

TABLE 3 (cont.)

Station	Description*	Aug. 1957	Feb. 1959	Mar. 1959
Section "E"				
379+90 to 382+00 Lt		Dry	Dry	Dry
379+40 to 380+85 Lt.	common outlet -new			
378+82 to 379+90 Obl. & Lt.				
384+50 Lt.	Old Trans. UD	Dry	240 gpd	Dry
388+75 to 389+50 Rt.	(Flows into stab.trench) Old	Not listed	2880 gpd	2700 gpd
391+50 Lt.	Trans. U.D. (old)	Slight flow of water in pipe and in gravel	8640 gpd	8640 gpd
394+05	Old Trans. U.D.	Dry	Dry	Dry
394+30 to 399+00 Rt.	Rehab. (Feeds into D.I. which carries surface water)	Very slight flow of water	1728 gpd	1005 gpd
394+50 to 398+00 Lt	New common outlet	Dry	Dry	Dry
394+50 to 397+65 Lt.	New			
398+50 Lt.	Old Obl. Trans. U.D.	Pipe Dry. Gravel below wet	Pipe drip Seepage under pipe	Same
399+00 Rt.	Rehab. U.D.	Dry	Dry	Dry
400+80 Rt.	Old Obl. Trans. U.D.	Not listed	Dry	Dry
409+07 to 411+82	(Flow into D.I. which carries other surface runoff)	Dry	864 gpd	Dry
417+00 to 420+30 Rt. (Flow in DI which carries other surface water)	Rehab. U.D.	Dry	Flow(?)	Dry

*Old refers to 1954 Contract. New & Rehab. refers to 1957 Contract.

TABLE 4

Stabilization Trenches
8" PMP Outlets

Section "D"

Sta.	Aug. 1957	Feb. 1959	Mar. 1959
196+80	Small flow of water from pipe	Flow in bed under pipes	No change
204+15	Not listed	21,500 gpd	5,400 gpd
211+00	Dry	Dry	Dry
214+00	Small flow of water from under PMP	Pipe wet, very wet under pipe	Pipe dry,wet under pipe
215+60	Dry	Dry	Dry
220+00	Dry	Dry	Dry
226+00	Small flow of water	Pipe dry - marshy and wet under pipe	Same
229+40	Small flow of water	Wet under pipe	Same
238+00	Dry	Dry	Dry
246+50	Dry	Dry	Dry
248+50	Dry	Dry	Dry
257+00	Dry	Dry	Dry
258+00	Dry	Lost in slide area	
258+50	Pipe dry. Gravel wet below	Lost in slide area	
259+50	Dry	Lost in slide area	
260+40	Very small flow of water	" " " "	
261+50	Dry	" " " "	
267+00	Pipe dry. Gravel below wet	Dry	Dry
269+50	Pipe dry. Gravel below damp	2,880 gpd	Trickle
278+30	Pipe dry. Water flowing from gravel below pipe	Seepage under pipe	Same
279+00	Not listed	Wet and marshy at outlet	Same
284+25	Very small flow of water	14,400 gpd	180 gpd
299+00	Not listed	Could not locate	
300+50	Very slight flow of water	Dry	Dry
305+60	Dry	Dry	Dry
306+75	Drip from pipe	Pipe dry, damp under pipe	Same
308+69	Dry	360 gpd	Dry
310+70	Pipe dry, gravel below damp	360 gpd	Dry
312+75	Slight flow of water through PMP	Could not read due to high flow in R.C.B.	

TABLE 4 (Cont.)

	Sta.	Aug. 1957	Feb. 1959	Mar. 1959
Section "D"	313+80	Slight flow of water	Drip from pipe - marshy	Same
	319+65	Pipe and gravel below damp	Could not locate	
	322+00	Not listed	8,800 gpd	Pipe damp, seepage under pipe
	322+87	Slight drip from pipe	7,200 gpd	3,600 gpd
	323+50	Not listed	Dry	Dry
	325+50	Dry	Seepage from under pipe	Same
	327+00	Dry	Seepage from under pipe	Dry
	328+20	Dry	Dry	Dry
	330+00	Slight drip from pipe	Seepage under pipe	Same
	337+00	Dry	Seepage under pipe	Same
	337+50	Pipe damp - free water in gravel below	360 gpd	Damp under pipe
	338+50	Dry	Seepage under pipe	Same
	353+85	Damp	Slipout - pipe end covered - very wet	
	366+00	Pipe 1/3 plugged damp no flow of water	36,000 gpd	36,000 gpd
	369+45	Pipe dry. Gravel below damp. No flow of water	2,160 gpd	2,160 gpd
Section "E"	363+50	Dry	Dry	Dry
	364+00	Dry	Dry	Dry
	368+00	Medium flow of water	5,400 gpd	5,400 gpd
	371+45	Pipe dry. Slight flow of water in gravel below P.M.P.	Pipe dry. Very wet around pipe	Same
	374+00	Dry	2,880 gpd	Drip
	376+00	Dry	Dry	Dry
	377+00	Dry	Dry	Dry
	383+30	Not listed	Outlet covered fill slope	rebuilt
	388+50	Medium flow to junction box	2,800 gpd	2,700 gpd
	410+85	Dry	Dry	Dry

TABLE 5

PAVEMENT SEEPAGES

	Station	February 25 & 26, 1959	March 9 & 10, 1959
Section "D"	182+	2 spots on SB lanes	Same
	185 to 188	Several spots on SB lanes	2 still active
	190 to 191	Several on SB lanes 2 on NB lanes	None active
	199	1 on SB inner lane 2 on NB outer lane	None
	204+50 to 205+50	NB outer lane	None
	207+	SB outer lane	None
	210+	SB outer lane NB & across ℄	None
	227 to 230	SB outer lane NB outer lane	None
	234+50	SB inner lane	Active
	236+	SB outer lane	None
	242+50	SB & NB lanes	None
	245 to 247	SB lanes Outer lane	None
	247 to 248+50	SB lanes & NB inside lane	None
	250+50	NB outer lane	None
	255+50 to 256+50	NB outer lane	None
	275+00	NB outer lane	None
	287+50	NB outer lane	None
	291+00	SB outer lane	None
	297+29	SB outer lane	None
	300+00	NB outer lane	None
	300+50	SB outer lane	None
	306 to 307	SB outer lane	None
	309 to 311	SB outer lane	None
	313 to 320	SB outer lane	70% of the seepages still wet
	321	℄ several spots	None
	322+50 to 323	Large area in SB lanes	None
	325+70	Large area over 18" CMP across all lanes	Reduced in area
	326+50	℄	None
	330+00	Several spots on inside SB lanes & outside NB lanes	None
	346+50 & 349	Several spots on SB lanes	None
	350+25	℄ of SB lanes	None
	352 to 353	SB lanes	None
	365	NB outer lane	Still active
	368	NB lanes	None
Section "E"	366	SB outer lane	None
	370	SB " "	"
	372	℄	"
	386+50	SB outer lane	"
	390 to 392	SB " "	"
	402	SB lanes	Appears to be a spring in roadbed

TABLE 6

CUT BANK SEEPAGES

	Station		February 1959	March 1959
Section "D"	190+ to 194+50 Rt. & 190 Rt.		3 Seeps Seep seems to feed into and flows across roadbed	3 seeps structural section & out the left side
	195± to 202±	Rt.	7 seeps	3 seeps
	205± to 211±	Rt.	Wet cut banks	3 " active
	213± to 218±	Rt.	Several small seeps	1 active
	221± to 224+50	Rt.	Seeps at 223+50	Same
	231± to 235±	Rt.	2 seeps	Same
	231± to 235±	Lt.	Wet mud flows	Drying-no active seeps
	251± to 256±	Rt.	Wet cut bank- small slides	Drying
	" "	Lt.	Wet - small slide	Dry
	261± to 265±	Rt.	Very wet - slides	Spring
	268± to 271±	Rt.	Seepages	2 active seeps
	273± to 276±	Rt.	Small wet slides	Dry
	277± to 282±	Rt.	Several small seeps	"
	286± to 295±	Rt.	Several small slides & seeps	Few damp spots
	302± to 308±	Rt.	Stream from bench - few seeps	Seep from bench
	309+00	Rt.	Seeps have no drainage must cross road	Dry
	323± to 328±	Rt.	Small slides - few seeps	"
	332± to 337±	Rt.	Slides - N.B. lanes heaved	Active spring at Sta. 336±
	" "	Lt.	Small slide	Dry
	344± to 348±	Rt.	Several seeps	3 seeps active
	352± to 358±	Rt.	5 seeps	2 seeps
	353+50	Rt.	Flow from bench	Dry
	360± to 364±	Rt.	Several seeps	Still active
	367± to 369±	Rt.	" "	Flow reduced
Section "E"	363± to 366±	Rt.	Wet cut banks	1 active seep Sta. 366±
	376± to 383±	Rt.	Slides-wet cut banks 7 horiz. drains-no slides over drains	Wet cut banks
	393± to 398	Rt.	Wet cut slopes	1 seep
	401± to 412±	Rt.	Wet banks-small slides	1 seep at Sta. 409
	401± t0 412±	Lt.	Wet cut banks	Same

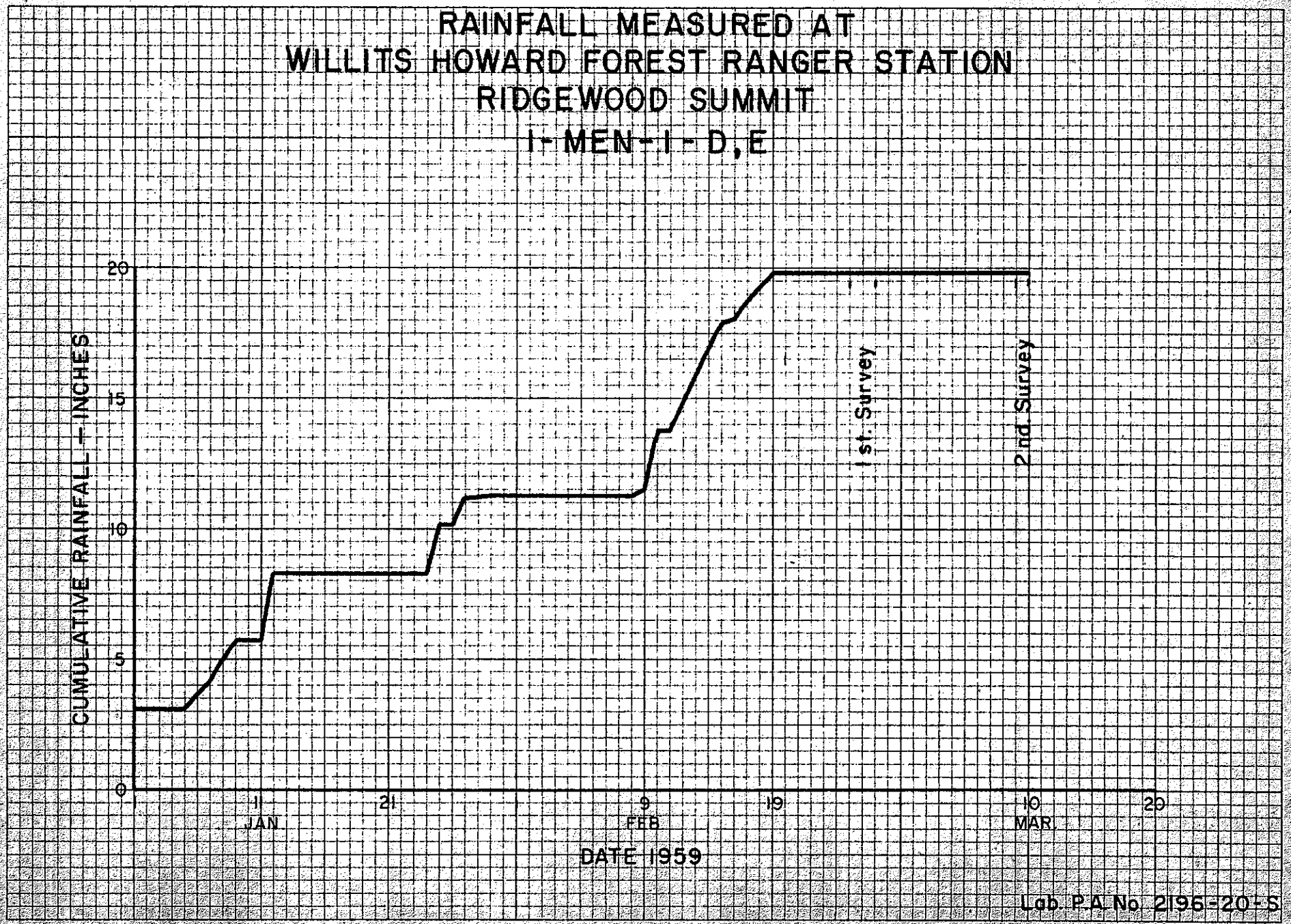
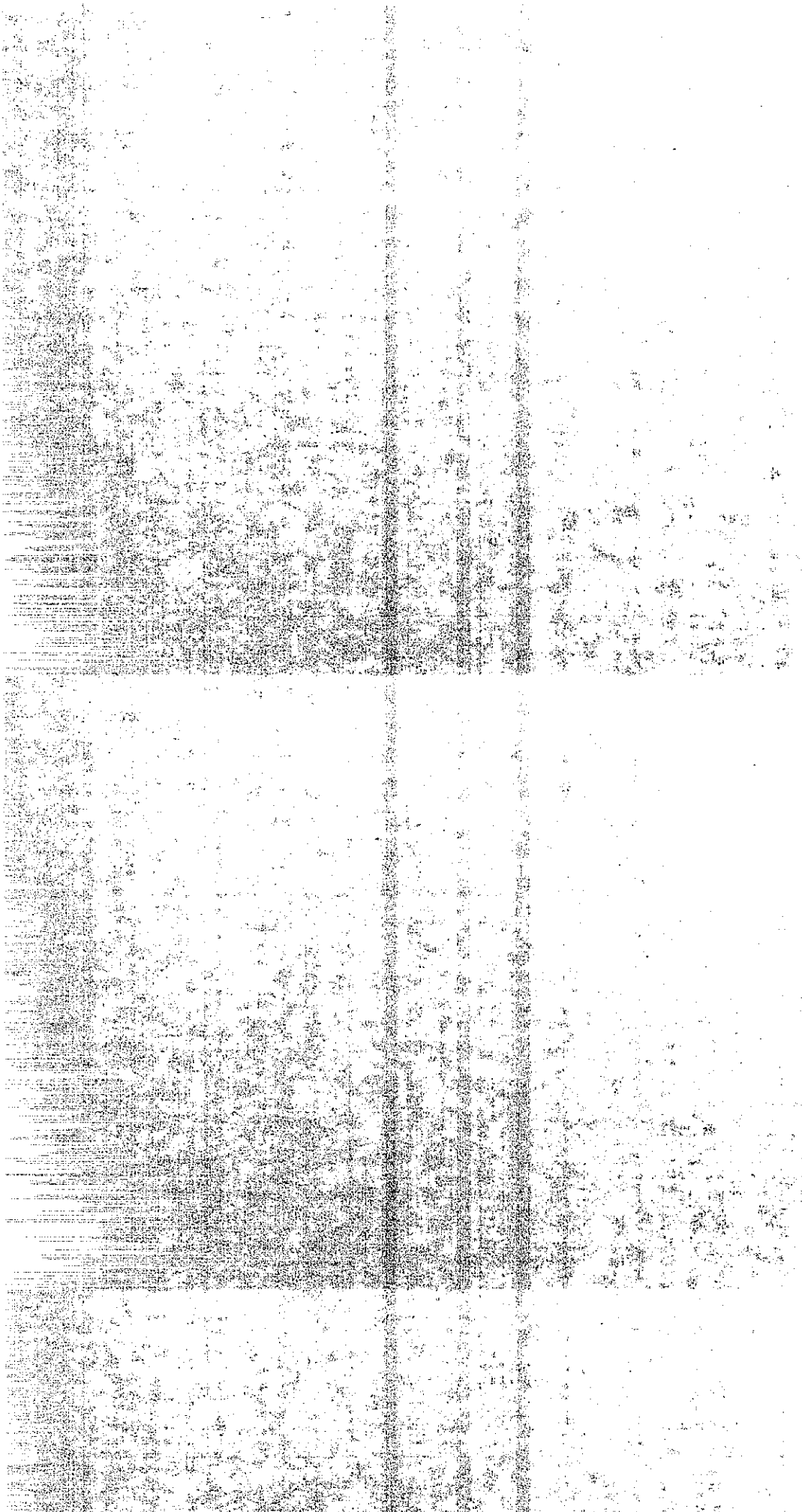
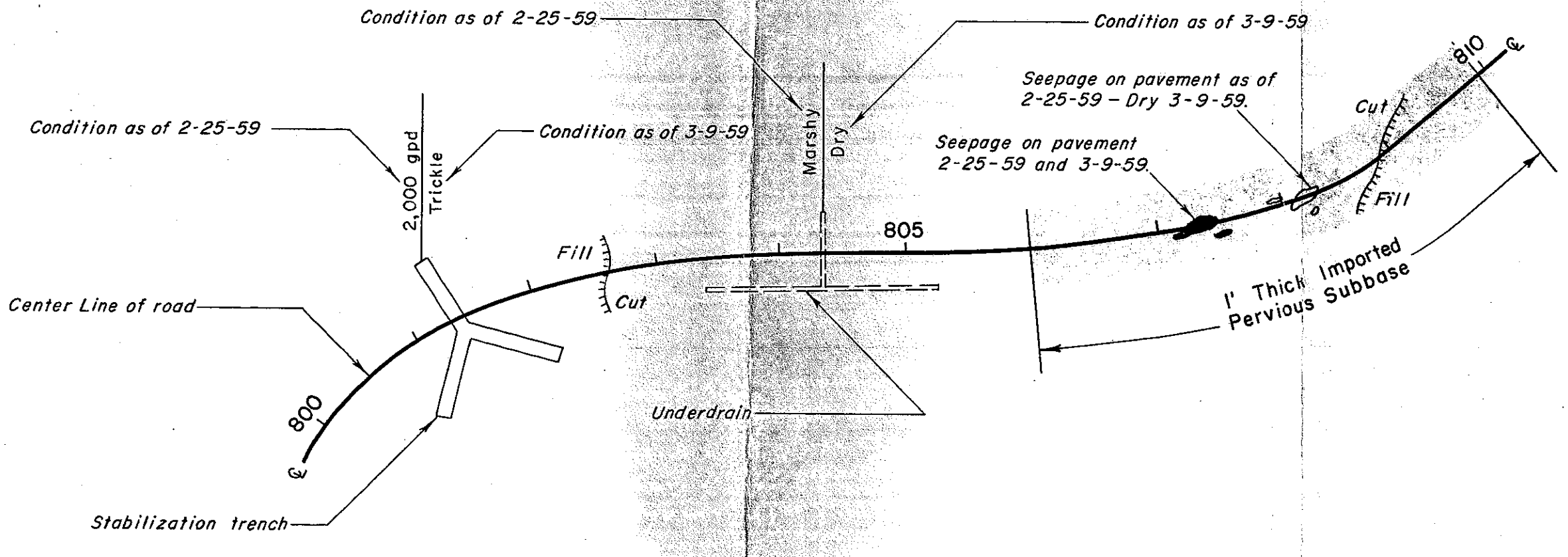


Figure No. 1



LEGEND SHEET



NOTES:

1. "Condition" refers to flow in gallons per day or moisture conditions of area in vicinity of drainage outlet.
2. Alignment and construction items taken from drawings for Contract Numbers: 53-ITC12-F, 54-ITC18, 58-ITC12.

STATE OF CALIFORNIA DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT

SEEPAGE INVESTIGATION

Road I-Men-1-D,E

4.1 Miles North of Forsythe Creek to Ridgewood Summit

LEGEND SHEET

DWG. NO. 59-258-2196	SUBMITTED BY: J. W. Smith, SENIOR MATERIALS & RESEARCH ENGR.		DATE 6-21-60
DRAWN BY C.L. & M.I.	APPROVED BY: A. E. Fink, SUPV. MATERIALS & RESEARCH ENGR.		SHEET NO 1 OF 12 SHEETS
CHECKED BY C.R.